PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G07D 5/08 // G07F 3/02

A1

(11) International Publication Number: WO 00/25274

(43) International Publication Date: 4 May 2000 (04.05.00)

(21) International Application Number: PCT/SE99/01927

(22) International Filing Date: 25 October 1999 (25.10.99)

(30) Priority Data:
9803656-9 23 October 1998 (23.10.98) SE

(71) Applicant *(for all designated States except US)*: SCAN COIN INDUSTRIES AB [SE/SE]; Jägershillgatan 26, S-213 75 Malmö (SE).

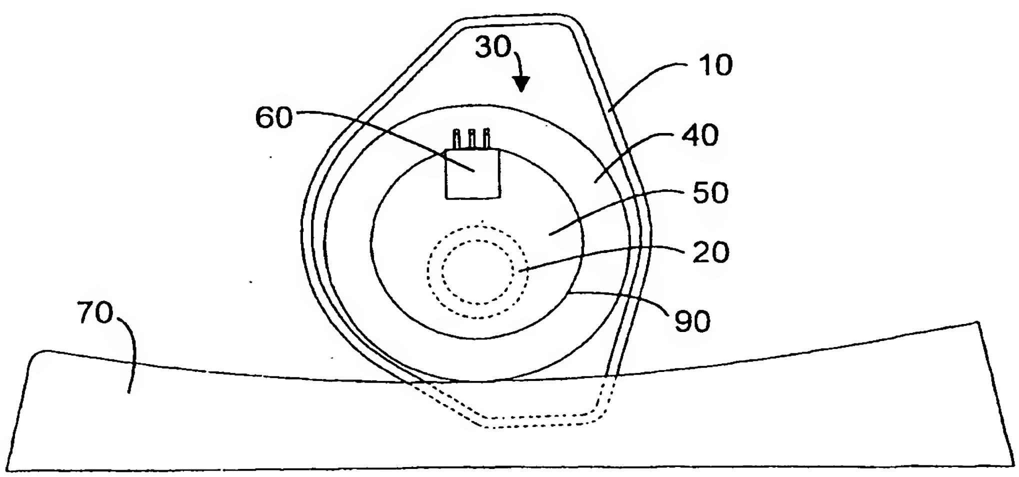
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: HOWELLS, Geoffrey [GB/GB]; 18 Cholderton, Near Salisbury, Wiltshire SP4 0DL (GB).

(74) Agents: STRÖM, Tore et al.; Ström & Gulliksson AB, P.O. Box 4188, S-203 13 Malmö (SE).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: BIMETALLIC COIN DISCRIMINATING DEVICE AND METHOD



(57) Abstract

A coin discriminating device has first and second coils (10, 20) positioned to induce and detect eddy currents in an outer ring (40) and an inner disk (50), respectively, of a bimetallic coin (30). A storage device is adapted to store coin reference data, and a logic device is adapted to determine an identity of the coin by comparing the coin reference data to data obtained from the detected eddy currents and related to the conductivity of the coin. A magnetic sensor (60) is coupled to the logic device and is positioned to detect a magnetic field generated by at least one of the first and second coils (10, 20), when the coin (30) is positioned betwwen the first and second coils and the magnetic sensor. The logic device uses data obtained by the magnetic sensor and related to the permeability of the coin when determining the identity of the coin (30).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

BIMETALLIC COIN DISCRIMINATING DEVICE AND METHOD

Technical Field

The present invention relates to a coin discriminating device of the type having first and second coils positioned to induce and detect eddy currents in an outer ring and an inner disk, respectively, of a bimetallic coin, where a storage device is adapted to store coin reference data and a logic device is adapted to determine an identity of the coin by comparing the coin reference data to data obtained from the detected eddy currents and related to the conductivity of the coin.

The present invention also relates to a method of identifying a bimetallic coin, and to a coin processing machine including a coin discriminating device of the above type.

Description of the Prior Art

Coin discriminators, which are arranged to measure the electric characteristics, e.g. the resistance or conductivity, of a coin by exposing it to a magnetic pulse and detecting the decay of eddy currents induced in the coin, are generally known in the technical field. Such coin discriminators are used in a variety of coin processing machines, such as coin counting machines, coin sorting machines, coin validators for vending and gaming machines, etc. Previously known coin processing machines are for instance disclosed in WO 97/07485 and WO 87/07742.

The way in which such coin discriminators operate is described in e.g. EP-B-0 119 000, in which a coin testing arrangement comprises a transmitter coil, which is pulsed with a rectangular voltage pulse so as to generate a magnetic pulse, which is induced in a coin when being moved past the transmitter coil along a coin rail. The eddy currents thus generated in the coin give rise to a magnetic

field, which is monitored or detected by a receiver coil. The receiver coil may be a separate coil or may alternatively be constituted by the transmitter coil having two operating modes. By monitoring the decay of the eddy currents induced in the coin, a value or reading representative of the coin conductivity may be obtained, since the rate of decay is a function thereof.

One embodiment of EP-B-0 119 000 uses two transmitter coils with different effective cross-sectional areas. The large coil is larger than the largest acceptable coin, whereas the small coil is smaller than the smallest coin. The position of the small coil is such that the effective cross-sectional area thereof is covered by the smallest coin when passing along the coin rail.

The purpose of the small coil is to solve a problem that can occur if only a large coil was used. The readings from the large coil are a function of the conductivity and diameter of the coin. A large diameter and a high conductivity both produce large coin readings. Hence, there is a problem in that coins of different diameter *and* conductivity can produce identical readings. For example, a British 2p copper coin and an aluminium token of 2 mm smaller diameter produce identical readings from the large coil. The small coil produces a signal that depends on the conductivity, but is independent of diameter. Thus, aluminium and copper may be differentiated by the small coil. The small coil cannot be used alone, because coins of the same material but different diameter give the same readings.

Another prior art coin discriminator is disclosed in EP-B-0 300 781.

While the above coin discriminators often are sufficient for traditional, homogeneous coins made of a single metal or metal alloy, the above prior art discriminators are less useful for successfully

discriminating also among bimetallic coins, as will be briefly addressed below.

In recent years, bimetallic coins have been issued on the market in different countries. Well known examples of bimetallic coins are the French 10F, the British £2, the Canadian $2 and the 1 and 2 Euro coins.

Bimetallic coins are made as follows. Outer rings and central disks are punched from sheets (also known as blanks) of the two metal or metal alloys, of which the bi-metallic coin is to be made. The disk is then fitted into the ring, and the coin is minted. Minting consists of pressing the coin between two hardened dies. The dies stamp the head and tail pattern onto the coin and also force the disk and ring together. The joint between the disk and ring is called a bond.

When identifying a bimetallic coin, there are three conductivities to be considered: the inner disk, the outer ring and the bond between them. The conductivities of the inner disk and outer ring depend on the metals used and do not change. The conductivity of the bond between the two metals, however, may vary to a large extent. The bond may be a perfect conductor, if freshly cut metal surfaces are pushed hard together (molecular welding). However, if the inner disk and outer ring are covered in an oxide layer before they are joined together, the bond will conduct less well. In extreme cases, with a thick oxide layer, the bond will not conduct at all. In addition, bond conductivity is even more complex, since it also depends on the voltage of the eddy currents induced for the measurement. A large measurement voltage will "punch through" the oxide layer and indicate a higher conductivity than a low voltage. In coin discriminators, the voltages across the bond are small and these non-linear effects are significant.

As a result, the poorly defined bond conductivity in bimetallic coins causes problems for many existing coin

discriminators. With bimetallic coins, the variability of the bond causes different readings from coins of the same type, thereby making a positive identification of the coin all the more difficult. For instance, in the dual transmitter coil arrangement of aforesaid EP-B-0 119 000, the small coil is located close to the coin rail (so as to cover also very small monometallic coins), thereby generating eddy currents in a bimetallic coin, which will cross the bond and cause great uncertainty as regards the conductivity reading.

GB-A-2 323 200 discloses a coin validator for bimetallic coins. An oval-shaped sensor 16 induces eddy currents, which are confined to the outer ring of the bimetallic coin. These eddy currents are detected and used for measuring the electric conductivity of the outer ring. A separate, smaller coil 14 is used for measuring the conductivity of the central disk of the bimetallic coin.

Summary of the Invention

It is an object of the present invention to provide an improved coin discriminator for identifying bimetallic coins. Moreover, an object of the invention is to allow the coin discriminator to be implemented by means of a small number of components.

The above objects are achieved by a coin discriminating device, a method of identifying a bimetallic coin and a coin processing machine according to the attached independent patent claims.

Other objects, features and advantages of the present invention are the subject of dependent claims.

Brief Description of the Drawings

The invention will now be described in more detail, reference being made to the accompanying drawing, in which:

Fig. 1 is a schematic perspective view of a coin discriminator according to one embodiment of the invention,

Fig. 2 is a schematic lateral view of the arrangement in Fig. 1, and

Fig. 3 is a schematic block diagram of a coin processing machine according to one aspect of the present invention.

Detailed Description

As shown in Figs 1 and 2 the coin discriminator comprises a large coil 10 and a small coil 20, both of which are mounted to a support member 80. The coils 10, 20 are connected to an electrical device (not shown) for supplying voltage pulses thereto.

The bimetallic coin 30 comprises a ring 40 of a first metal or alloy and a disk 50 of a second metal or alloy. A bond between the disk and the ring is labeled 90.

The coils 10, 20 act as transmitter coils for exposing the bimetallic coin 30, which is moved past the coin discriminator along a coin rail 70, to a respective magnetic pulse giving rise to eddy currents in the outer ring 40 and the inner disk 50 of the coin 30. Furthermore, the coils 10, 20 act as receiver coils for detecting the magnetic field variations generated by the eddy currents in the outer ring 40 and inner disk 50 and converting them into corresponding voltage signals. The voltage signals are supplied to a detector (not shown), which is arranged to measure the decay of the signals and in response determine a respective value of the conductivity of the outer ring 40 and inner disk 50. The determined conductivity values are subsequently used for identifying the coin 30.

The coin discriminator is arranged to carry out the conductivity measurements when the center of the coin 30 is aligned with the center of the coils 10, 20, i.e. when the coin is located as in Fig. 2. As shown in Fig 2, the small

coil 20 is mounted relatively high above the coin rail 70, thereby assuring that the induced eddy currents will flow essentially exclusively in the disk 50 without crossing the bond 90. Conversely, the eddy currents induced by the large coil 10 will flow essentially exclusively in the ring 40, again without crossing the bond 90. Hence, the eddy currents induced within the coin flow in concentric circles around the center of the coin, and none of the eddy currents crosses the bond 90 in the bimetallic coin. Thus, the conductivity measured is independent of the bond.

The duration and waveform of the voltage pulses supplied by the electrical device to the coils 10, 20 may be chosen in accordance with the actual application, as is readily realized by the skilled person.

For further improved accuracy, the inventive coin discriminator is provided with a magnetic sensor element 60, preferably a Hall element. The Hall element 60 is arranged to measure the magnetic permeability of the outer ring 40 and inner disk 50 of the coin 30. In this way coins with identical electric properties (e.g. conductivity) but different magnetic properties (e.g. permeability) may be differentiated.

The coils 10, 20 are driven to generate a respective magnetic field, to which the outer ring 40 and inner disk 50 are exposed. Depending on the magnetic properties of the ring 40 and disk 50, the magnetic fields will be influenced to different extents. The Hall element measures the amplitude of the magnetic fields produced by the coils. The amplitude of the magnetic field from the large coil 10 indicates the permeability of the outer ring 40 of the bimetallic coin 30. Similarly, the small coil 20 measures the permeability of the inner disk 50. In the preferred embodiment, because two measurements are obtained from the Hall element, some form of multiplexing must be used,

either frequency division multiplexing or time division multiplexing.

In frequency division multiplexing the large and small coils are driven by sine waves of different frequencies. For typical coins, frequencies of 9 kHz and 7 kHz would be suitable. The output from the Hall element is a waveform containing both frequencies. Using appropriate electronics, e.g. synchronous detection, the amplitudes of the two frequencies can be measured.

In time division multiplexing only one coil is driven at a time. For example, the small coil 20 can first be driven and the Hall element output measured. Then the large coil 10 is driven and the second measurement from the Hall element is made. Whichever method of multiplexing is used, the results are equivalent.

For the permeability measurement it is not required that the coin is exactly concentric with the coils.

In some applications it may be sufficient to measure the permeability of only one of the outer ring and the central disk of the bimetallic coin.

Referring now to Fig. 3, a coin processing machine 100 according to one aspect of the present invention is illustrated. In an exemplifying but not limiting sense, the coin processing machine 100 of Fig. 3 is selected to be a coin sorter. The mass of coins to be sorted by the machine 100 are deposited into a coin inlet 110. The coins are fed by a coin feeder 120, such as a hopper and/or an endless belt, to the coin discriminator 130, which has been described above with reference to Figs. 1 and 2. The coin discriminator 130 is operatively connected to a logic device 132 in the form of a CPU, which is operatively connected to a memory 134, such as a RAM, ROM, EEPROM or flash memory. The memory 134 stores a set of coin reference data, which is used by the logic device 132 to discriminate among the coins received through the coin inlet 110. More

specifically, the coin reference data relates to typical values of conductivity and permeability for all different types of coins, that the coin processing machine 100 is capable of processing.

The logic device 132 is programmed to receive measurement data obtained by the coils 10, 20 and the magnetic sensor element 60, said data relating to the conductivity of the outer ring 40 and the inner disk 50, respectively, as well as the permeability of at least one of the outer ring and inner disk. Once these measurement data have been received for a coin 30, the logic device 132 will read the coin reference data stored in the memory 134 and search for any matches. If both the conductivity and the permeability measured by the coin discriminator 130 correspond to one specific coin type defined by the coin reference data, then the type of coin 130 has been positively identified. Otherwise, the coin 30 is of an unknown type, which is handled by a coin reject device 140, which preferably will deliver the coin through an external opening in the machine 100, so that the coin may be removed by a user.

The coin types defined by the coin reference data in the memory 134 may preferably relate to the denomination of each different coin type, which is to be handled by the coin processing machine 100.

Once the type or identity of the coin 30 has been determined by the coin discriminator 130 and the logic device 132, the coin 30 is passed to a coin sorter 150, which uses the identified coin type to sort the coin 30 into one specific coin box, etc., in a coin storage 160. The coin boxes, etc., in the coin storage 160 are preferably externally accessible for the user of the machine 100.

The invention has been described above with reference to a few embodiment examples. However, embodiments other

than the ones described above are possible within the scope of the invention, as defined by the appended independent patent claims.

CLAIMS

1. A coin discriminating device, comprising: first and second coils (10, 20) positioned to induce and detect eddy currents in an outer ring (40) and an inner disk (50), respectively, of a bimetallic coin (30); a storage device (134) adapted to store coin reference data; and a logic device (132) adapted to determine an identity of the coin by comparing said coin reference data to data obtained from the detected eddy currents and related to the conductivity of the coin, **characterized** by

a magnetic sensor (60) coupled to the logic device (132) and positioned to detect a magnetic field generated by at least one of the first and second coils (10, 20), when the coin (30) is positioned between the first and second coils and the magnetic sensor, wherein the logic device (132) is adapted to use data obtained by the magnetic sensor and related to the permeability of the coin when determining the identity of the coin (30).

2. A coin discriminating device according to claim 1, wherein the magnetic sensor (60) is a Hall element.

3. A coin discriminating device according to any preceding claim, wherein the magnetic sensor (60) is positioned to detect a respective magnetic field generated by the first coil (10) as well as the second coil (20).

4. A coin discriminating device according to any preceding claim, wherein the second coil (20) is positioned inside the first coil (10).

5. A method of identifying a bimetallic coin (30) having an outer ring (40) and an inner disk (50) by generating eddy currents essentially exclusively in the outer

ring and the inner disk, respectively, measuring the eddy currents thus induced so as to determine the electric conductivity of the outer ring and the inner risk, respectively, and using the electric conductivity of the outer ring and the inner disk, respectively, for identifying the coin (30), **characterized** by the further steps of

exposing the coin (30) to a magnetic field,

measuring the permeability of at least one of the outer ring (40) and inner disk (50), and

using the permeability when identifying the coin (30).

6. A method according to claim 5, wherein the outer ring (40) is exposed to a first magnetic field and the inner disk (50) is exposed to a second magnetic field.

7. A method according to claim 5 or 6, wherein the or each magnetic field varies in amplitude.

8. A method according to any of claims 5-7, wherein the or each magnetic field varies as a sinewave.

9. A method according to any of claims 7-8, wherein the steps of exposing, measuring and using are executed at a first frequency of the first magnetic field for the outer ring (40) and at a second frequency of the second magnetic field for the inner disk (50).

10. A method according to claim 9, wherein said first frequency is about 9 kHz.

11. A method according to claim 9 or 10, wherein said second frequency is about 7 kHz.

12. A coin processing machine comprising a coin inlet (110), a coin feeder (120), a coin discriminator (130) and a coin processor (150), the coin discriminator being coupled to the coin processor and being adapted to determine a type, identity or denomination of respective coins (30) received from the coin feeder, and being adapted to supply the determined type, identity or denomination to the coin processor, **characterized** in that the coin discriminator (130) comprises:

first and second coils (10, 20) positioned to induce and detect eddy currents in an outer ring (40) and an inner disk (50), respectively, of a bimetallic coin (30);

a magnetic sensor (60) positioned to detect a magnetic field generated by at least one of the first and second coils (10, 20), when the coin (30) is positioned between the first and second coils and the magnetic sensor;

a storage device (134) adapted to store coin reference data; and

a logic device (132) adapted to determine an identity of the coin by comparing said coin reference data to data obtained from the detected eddy currents and related to the conductivity of the coin, as well as data obtained by the magnetic sensor and related to the permeability of the coin.

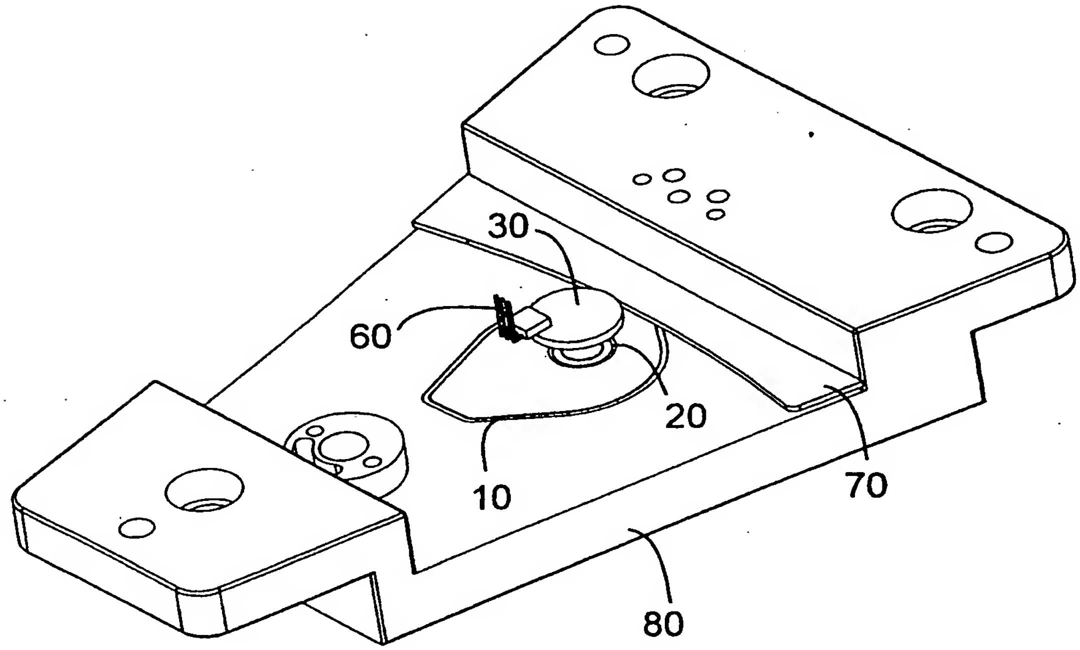


FIG 1

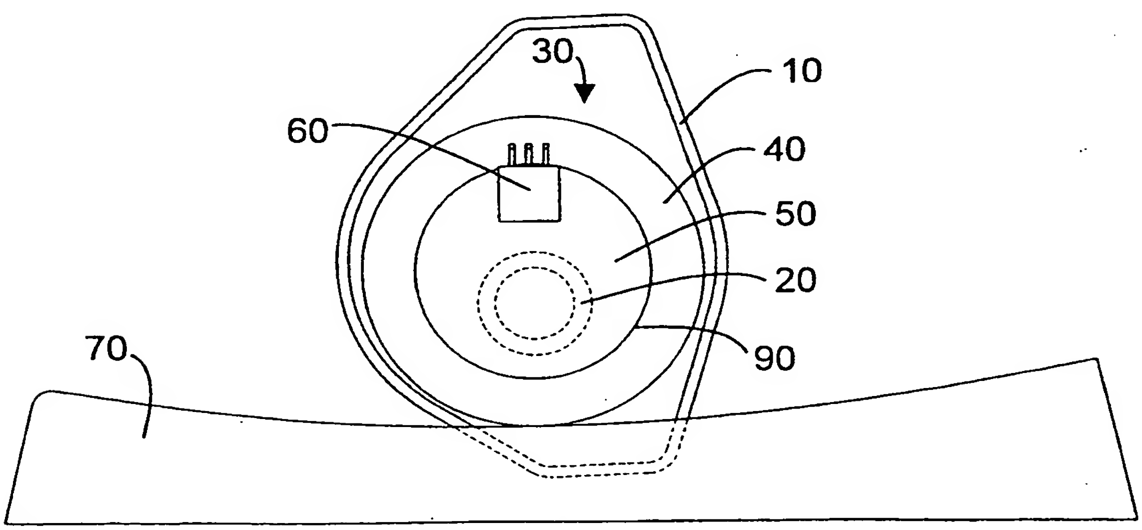


FIG 2

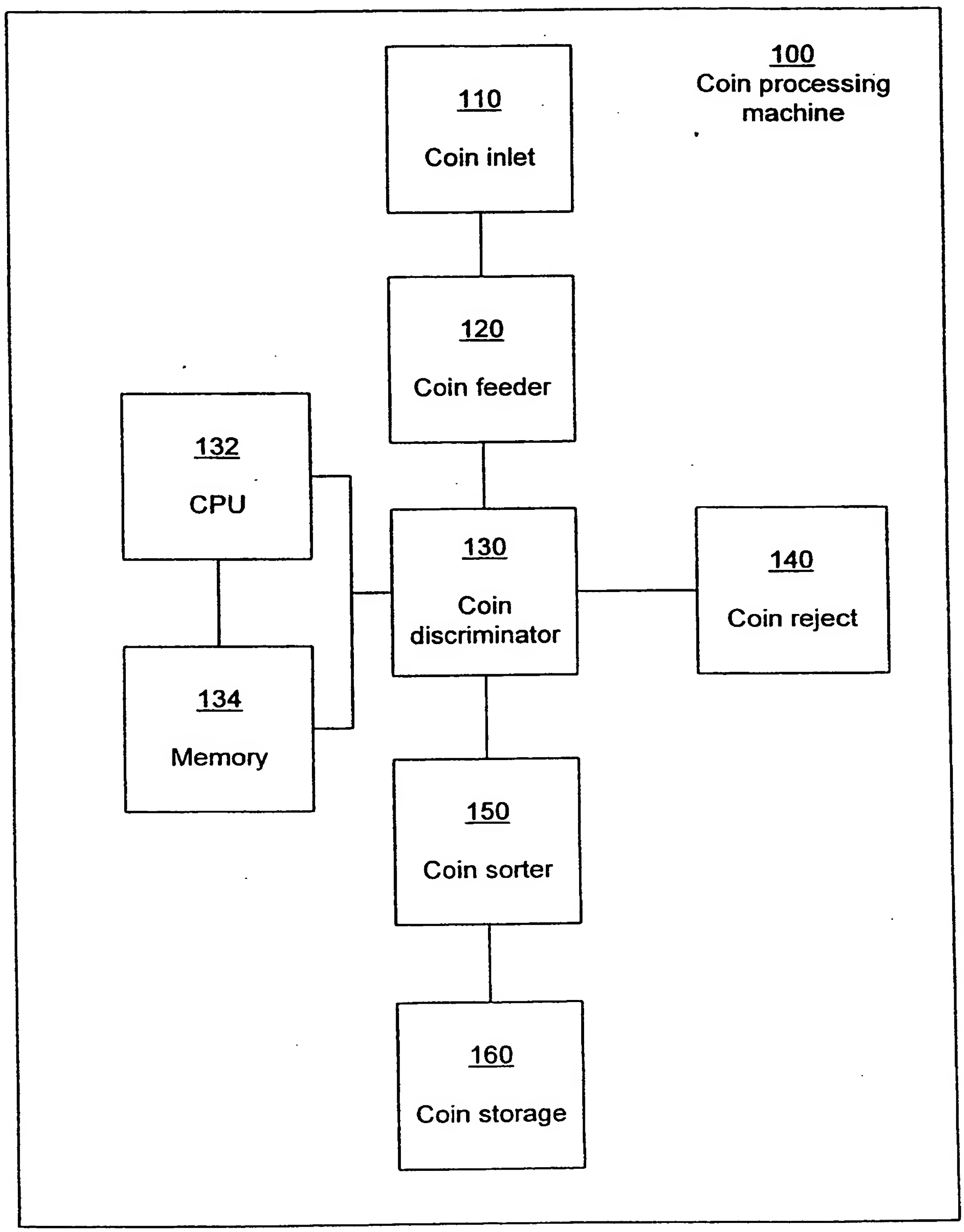

100
Coin processing machine
110
Coin inlet
120
Coin feeder
132
CPU
130
Coin discriminator
140
Coin reject
134
Memory
150
Coin sorter
160
Coin storage

FIG 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/01927

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G07D 5/08 // G07F 3/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G07D, G07F, G01N, G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GB 2323200 A (MARS, INCORPORATED), 15 Sept 1998 (15.09.98), page 2, line 11 - line 24 --	1-12
Y	GB 2266804 A (MARS INCORPORATED), 10 November 1993 (10.11.93), page 2, line 11 - line 15; page 14, line 13 - line 22 --	1-12
Y	US 5119916 A (CARMEN ET AL), 9 June 1992 (09.06.92), see especially details 226,228 --	1-12
A	GB 2135095 A (CHAPMAN CASH PROCESSING LIMITED), 22 August 1984 (22.08.84), Measuring eddy current decay --	

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 January 2000	16 -02- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Gunilla Jonsson / JA A Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 99/01927

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2323200 A	15/09/98	AU 6302598 A	09/09/98
		GB 9703769 D	00/00/00
		WO 9837522 A	27/08/98
GB 2266804 A	10/11/93	AU 4269393 A	29/11/93
		DE 69312486 D,T	29/01/98
		EP 0639288 A,B	22/02/95
		ES 2104151 T	01/10/97
		JP 7506687 T	20/07/95
		US 5609234 A	11/03/97
		WO 9322747 A	11/11/93
US 5119916 A	09/06/92	AU 7559191 A	21/10/91
		WO 9115003 A	03/10/91
GB 2135095 A	22/08/84	AT 42158 T	15/04/89
		AU 577777 B	06/10/88
		AU 2424284 A	16/08/84
		EP 0119000 A,B	19/09/84
		SE 0119000 T3	
		GB 2135492 A,B	30/08/84
		HK 93886 A	12/12/86
		JP 1773207 C	14/07/93
		JP 4054272 B	28/08/92
		JP 59189490 A	27/10/84
		MY 9987 A	31/12/87
		SG 71186 G	02/06/89
		US 4717006 A	05/01/88